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OPPORTUNITIES TO INTEGRATE DIGITAL INTELLIGENCE INTO AN AUTOMATED LOGISTICS MANAGEMENT SYSTEM ALONG THE VALUE CHAIN

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Abstract: *Factors that determine the effect of using automated management systems (AMS) in logistics are no longer just industrial, but also social and environmental, related to different structures in different parts of the world. In the current stage of industrial development, they are already forming the concept of modern production development using artificial intelligence and in logistics. Technological impacts dictate the tendency to continuously reduce manual, heavy and unattractive labor at the expense of higher productivity. The social aspect demands the discovery of new or preserving old jobs, and the environmental aspect imposes a lasting trend towards compliance with environmental standards and sustainable development parameters. The purpose of this report is to explore these differently impacting factors and on this basis to build an AMS of logistics across the value chain with the ability to incorporate digital intelligence.*

Keywords: AMS of Logistics, Digitization of Logistics, E-Logistics Systems, Artificial Intelligence

Introduction

The purpose of this report is to explore impacting factors and on this basis to build an AMS of logistics across the value chain with the ability to incorporate digital intelligence.

1.Global development and the role of logistic

Future global development will be characterized by long-term strategies and methods of designing and manufacturing new cyber-tech equipment and new service requirements. New robotic devices will be imposed, as the new information management devices can be included in this category. As a subject of this activity are all basic and auxiliary technological, production and information processes and activities, which should be

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logistically provided as well. This category may include the IT management tools included in: man-machine interfaces that establish communication and speech recognition; self-learning intelligent control systems based on artificial intelligence; devices with artificial intelligence and freely moving robots, etc.[4,8,20].

These global trends also create new requirements not only for the development of industrial enterprises and their production, but also for the approaches, forms and ways of improving their processes and activities. An important factor in this respect is the expansion of the spatial capabilities of logistics technologies. It is also related to better use of resources in this direction as well as better logistics services. Information provision of the logistics process includes familiarization with the practices and methods of organizing and managing information flows in logistics systems, the basics of the operation of logistic information systems and modern information and communication technologies in logistics. Logistics can also be defined as part of supply chain management by planning, implementing, controlling efficient and effective flow and storage of goods and services, serving and linking information between point of origin and point of consumption [5,11,12,14].

The need for logistical services among manufacturers and commercial companies is increasing significantly as a result of increased globalization of business and competition pressure. The main goal is to bring products and services into the market faster. Overall, the capabilities of logistics service providers vary widely, ranging from several major representatives who primarily offer transport services to established market leaders and those with a wide range and scope of logistics activities and services [1,22,25].

The trend towards higher value added services gives suppliers the opportunity to differentiate their business from their competitors as well as to strengthen customer relationships [18,26]. Thanks to the development of personalized services, the pressure on the logistics service industry is characterized by a strategic impact from the point of view of market coverage, improving the level of service and increasing the flexibility of changing customer requirements. As an example in this respect one can assume that one of the main requirements in our time is the so-called "Green logistics" [15,28]. Green supply chain studies have expanded considerably over recent decades, in connection with the growing importance of environmental components in the management of these chains. "The Green Supply Network" is a broad concept that includes different approaches by which companies work with their supplier and/or customer to improve the environmental performance of their operations. "Green" initiatives are also important for logistics. Logistics providers are gradually transforming the scope of their services by offering a shift from single business to a business model based on a wider range of services. As a result of this evolving process, they are ready to accept ecological transport options, as well as non-transport activities or a combination of both. Approaches are embedded in the development of an integrated package of initiatives to improve the environmental sustainability of services that logistics companies provide to their customers [6,19,24]. By that all this "green system" is an integral part of the supply chain AMS.

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Of particular importance for this whole process, including horizontal integration, is the study of the essence of logistics operations and the role of the information component. This is of particular importance also in view of the fact that this is the most revolutionary component leading to quality changes of the entire logistical process [3,7,10,17]. Therefore, we will look at and analyze the functions and impact of logistics information processes in their development and application in AMS.

2.Basic principles of structuring (forming) of logistical information designed for the AMS.

In order to ensure that logistic information adequately meets the requirements of logistics systems and effectively supports the management and operational control process, it must be based on the relevant principles underpinning its development, such as availability, accessibility, accuracy, timeliness, rapid response to failures and deviations, flexibility, visibility, transparency, etc. (Fig. 1).

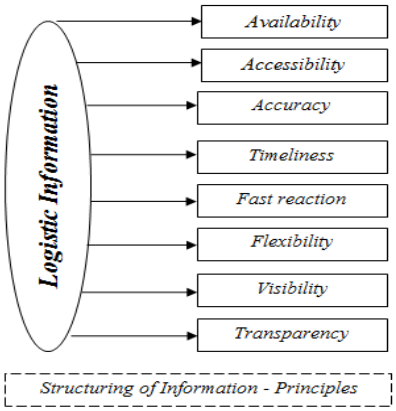

Fig.1.Principles of structuring logistical information

Information systems in logistics can be created to manage material flows at the level of an individual enterprise but can facilitate the organization of logistical processes in the territories of the regions, countries and even in a group of countries (typical of the EU), Figure 2.

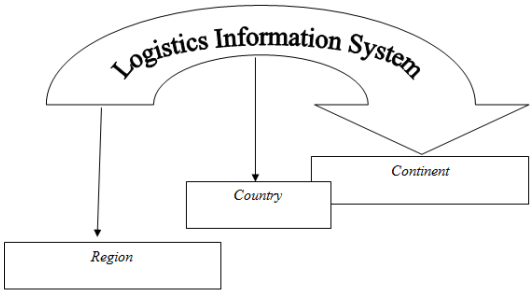

Fig 2.Levels of management of logistic information processes

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When building automation-based logistic information systems (AMS), certain requirements must also be met, including:

1. Ability to use hardware and software modules.
2. Possibility of phased creation of a logistic information system.
3. Flexibility of the system with regard to the specific requirements of a particular logistic connection.
4. Ability to accept the user-system of the human-machine dialogue.
5. Clearly fix the interconnections in the logistics system inside and outside the environment.
6. Inadmissibility of incompatible solutions at the lowest level of the logistics system.
7. Consecutive building of interfaces for the various subsystems of the automated logistics system.
8. What is the role and place of the logistics components in the logistics system's UA.
9. Recognition of the mutual influence of material and information processes within the system.
10. Achieving synergies by integrating system connections vertically and horizontally.

These requirements are shown in Figure 3.

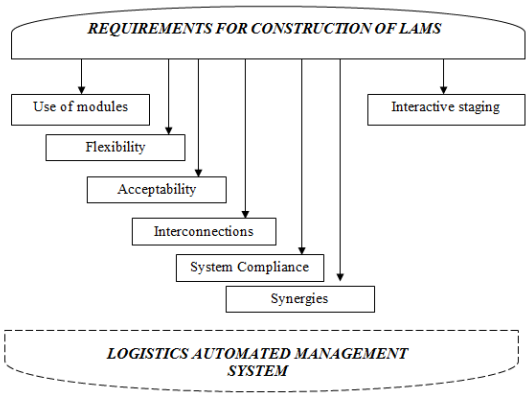

Fig.3.Requirements for building automated logistics information processes

3.Establishment of an AMS with the possibility of phased creation and development

The stage is directly related to the selection of the AMS components, including hardware and software modules. The hardware module is a unified functional unit for communication and electronic equipment, structured and produced in the form of an independent product. The software module can be considered as a single, somewhat independent, software component that performs a certain function in the general software. Complying with the principle of using software and hardware modules will allow: Ensuring compatibility of computers and software at different levels of logistics management; will increase the efficiency of the operation of logistics information systems; will reduce costs; the construction of such systems will be accelerated; will cover the whole logistics process along the value chain [9,13,16,21].

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Logistic information systems based on automated logistics processes like other automated management systems are constantly evolving. This means that when designing them, it is necessary to ensure the possibility of constantly increasing the number of automation objects, the possibility of extending the composition of functions and the number of tasks performed by the information system. It should be kept in mind that determining the stages of system creation, the selection of priority tasks has a major impact on the subsequent development of the automated logistics information system and the effectiveness of its operation [23,27,29].

Another problem is clearly identifying the intersections of logistics processes with other business processes. The points of material flow crossing and the information flow cross the boundaries of competence and responsibility of individual business units or across the boundaries of independent research organizations.

Ensuring a smooth overcoming of this intersection is one of the important tasks of building a logistics AMS. Important tasks in this area are also:

Providing system flexibility with regard to the specific requirements of logistic subsystems; **Ensuring acceptable user-level access** from the lowest level through the human-machine dialogue to the highest level of automation and **achieving synergy** by integrating logistics systems into vertical and horizontal dimensions.

4.Application of modern information technologies for automation of logistic information processes - AMS

In modern logistics, the use of information technology is an integral part of the whole process. It is difficult to imagine the construction and organization of the goods delivery process without the timely exchange of information and without prompt response to market requirements. To date, it is virtually impossible to ensure the quality of goods and services required by the client without using modern information systems and software tools to plan, analyze, and support business logistics solutions.

The role of the electronic component (E - logistics) in the AMS of logistics

E - Logistics is an abbreviation of the term "Electronic Logistics". Electronic logistics is alongside the E-Commerce and E-Procurement functions and is part of the so-called E-Business. E-business means electronic business transactions where business processes from each operating area are supported by electronic telecommunication services. E-business operators are assisted by so-called executive partners in the supply chain. E-Logistics is a strictly regarded part of E-Fulfillment, and E-Realization is part of the e-business. The tasks of E-Implementation are typically performed by specialized logistics service providers. Once the contract has been signed and the online order has reached the service provider, E-Realization controls the execution of all procedures so that the contractual obligations to the client can be met. E-Logistics makes it possible to plan, implement and control logistics activities or tasks by using Internet technologies to economically improve logistics services and to strengthen Supply Chain. This includes, for example, necessary steps to implement e-

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commerce transactions in the field of order acceptance, storage, commissioning, packing, franking and dispatching.

Prerequisites and Conditions for Including and Implementing an Electronic Component in AMS of Logistics:

• Integration of Internet-based systems into the portfolio of existing IT systems;

• Further development of classical organizational processes and procedures;

• Intercompany or interdepartmental cooperation with the clear goal of focusing all partners in the supply chain to overcome information barriers;

• The complexity of integrating electronic logistics solutions into existing architectures and applications should not be underestimated.

These prerequisites are shown in Figure 4.

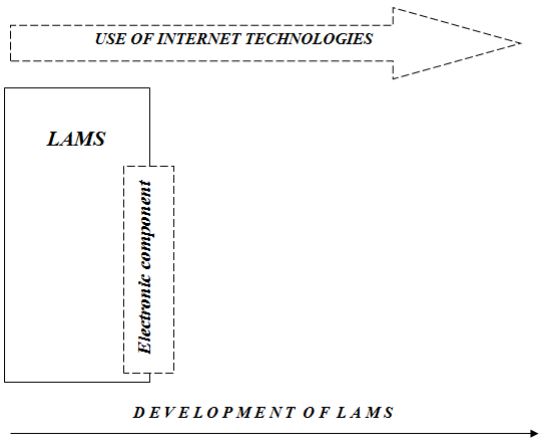

Fig.4.Preconditions and conditions for the inclusion of the electronic component in the logistic AMS

Advantage of the electronic component E-Logistics is the possibility of economic growth through the realization of the logistic tasks with the use of the Internet technologies. In addition, the service philosophy of classical logistics and e-commerce can be improved.

E-logistics is the collective expression of the logistics processes in a company that are defined electronically. It is considered a kind of base in which all components can be connected. In Figure 5 shows the links between the components of E-logistics.

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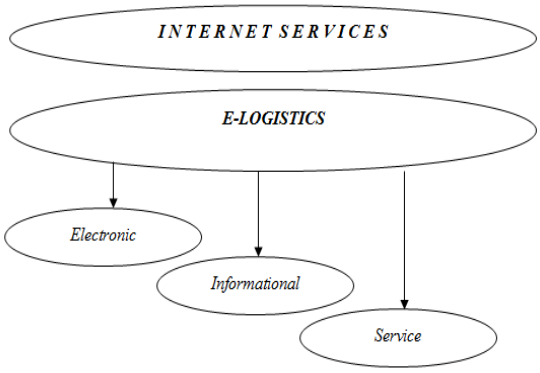

Fig.5.Links between E-logistics components

Without an electronic component in the logistics AMS, there can be no effective and unhindered handling of the movement of goods in the field of e-business. This is related to the cautious planning and development of all the logistics processes and systems necessary for the electronic processing of transactions. Electronic logistics as a component of logistics AMS is also the common denominator for future organization and planning of logistics systems and processes so that electronic dispatching of business processes can be ensured within certain limits.

As globalization in industrial processes continues to grow rapidly, the Internet of consumers is increasingly becoming a global market for services and goods. Companies are forced through e-logistics and e-business at a tremendous pace to provide new goods, information and services. Without electronic logistics, companies will not be competitive on the market. How successful a company is on the market depends on how much individual value chain elements are aligned to in order to create a better value, E-Logistics is becoming increasingly important for companies to survive in this competitive environment. Thanks to the rapid spread of communications and information technology, the internet is now becoming a day-to-day business in companies. Many of the orders are handled over the Internet. More and more company employees have access to the Internet at work and work directly in and with electronic logistics. Electronic logistics is becoming increasingly important both for itself and for e-business.

Logistics Information System (L-AMS) as an element of company AMS

L-AMS is seen as an element of the company information system (AMS) due to the fact that it can only function if it is at the same E-level as the firm has. This is shown in Figure 6.

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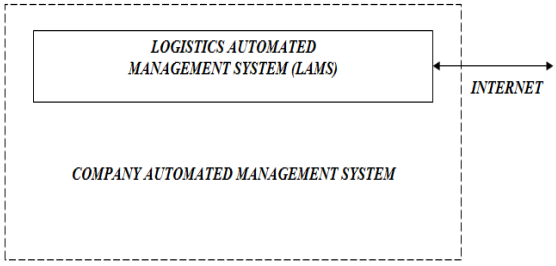

Fig.6.L-AMS levels

Therefore, the digitization of logistics as an element of company digitization is also seen as a complex solution with the digitization of all corporate activities.

Inter-structural and external structural relationships in L-AMS as an element of company AMS

The functional dependence between L-AMS and internal and external relationships can be expressed with dependence:

$$L\text{-}AMS = F(Sv, Sw)$$

where:

Sv - internal interconnections.

Sw - external interconnections.

The inter-structural relationships are examined and ranked by relevance and belonging to certain L-AMS attributes. Here are the interconnections from the logistics of the material flow realized through the Internet of Things. This is the possibility of using a digital logistics information system related to the material flow in the company. Here is also the building a logistic virtual model in the virtual reality with a mirror image - software execution.

External links are related to the types of logistics systems, including links to external suppliers, customers, and so on.

Formation of logistic information depots for the storage of information modules in the virtual reality as an element of L-AMS

First, this is an approach for building information storage sites for embedded logistic information systems (embedded systems), delivery of logistic information services over the Internet (embedded information systems - software). These are coded self-contained (by function and purpose) systems (software product) offered as a commercial product. Secondly, this is an approach for building cloud logistic information systems (nature and purpose), virtual reality or offering a virtual logistic cloud reality.

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Hybrid logistics AMS

The main difference between logistical AMS and other types of information systems is the level of integration of the information space.

The systematization of concepts in this area of research allows to distinguish three existing approaches to the definition of logistic AMS:

• L-AMS is part of the corporate information system;

• L-AMS is a higher degree of integration of software solutions and includes a corporate information system;

• L-AMS is an independent structure isolated from other information systems.

L-AMS integrates information logistics space horizontally and components located in different locations and regions of the world. Information flows in the business organization should be formed on the basis of the characteristics of the production and economic activity of the whole chain, through which the commodity from the raw materials becomes an end product and then through the sales system reaches the end user.

It is therefore obvious that L-AMS is in fact a higher order than the corporate information system (CIS), as it involves distributing products, purchasing raw materials and transporting them, which is beyond automated functions, i.e. LIS is a higher degree of CIS integration. Figure 7 illustrates the advantage of L-AMS as an integrated logistics space.

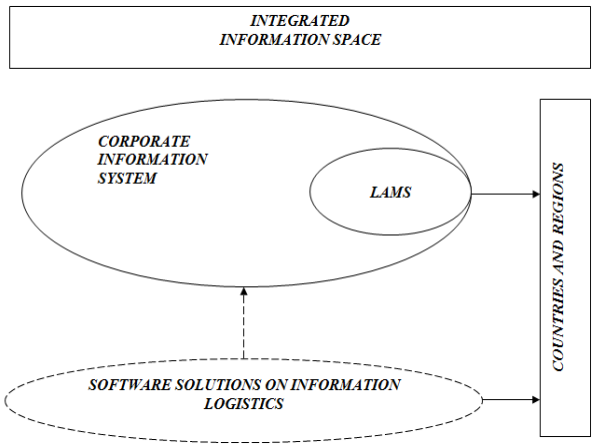

Fig.7.Integrated logistics information space

The second no less important issue for the construction of L-AMS is its functionality (functional structure).

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Before discussing the functionality of L-AMS, it is necessary to determine the types of information flows that penetrate the system. The specificity of L-AMS is determined by the fact that flow management is done both within the business organization and between the various participants in the logistics chain. In this regard, information flows are divided into two types:

• strategic (coordinating);

• operating.

Separate functions (functional subsystems) may be included in both types of data streams (e.g., inventory management).

The strategic (coordinated) flow includes the following key functions of L-AMS: Strategic Plan (Strategic Objectives); Capacity utilization plan (capacity constraints); Logistic plan (logistic needs); Production plan (production needs); Delivery plan (delivery needs).

Opportunities to include digital intelligence in L-AMS

The Digital Intelligence methodology forms a set of requirements that are necessary for the functioning of the logistics digital system. This requirement is also important from the point of view of the preliminary design of the technical levels of the logistics AMS. In this respect, the logistics information system adapts the following levels:

1. Technical level of the AMS system (E-logistics information system)

2. Technical level of the object (virtual or real logistic information object)

3. Artificial Intelligence (Managing Intelligence), which includes:

3.1. Scope of functions that Artificial Intelligence can perform (1 ... .n)

3.2. Functions that have full human substitution (F of the total number of n-functions)

Criteria for choosing the objects for the introduction of digital intelligence

The selection of objects begins with the study and analysis of the existing state of the objects. The purpose of the study is to determine the information and technical parameters of the objects in accordance with the requirements of their future development. Therefore, it should be defined their technical level at a given time and in the dynamics for the following years. This set of studies should also take into account the normative reference base used to determine these indicators.

Determining the number of criteria. Depending on the requirements of the systems, the number and composition of the criteria characterizing the status of the study object are determined. The importance of the individual criteria, which determine the necessary condition for justifying the choice of one or another object, depends on the pre-set objective in for them. Criteria must meet the conditions for making decisions about choosing objects for digital intelligence. We define the following sets of criteria:

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- system level criteria;
- Criteria for determining the rate of digitization;
- Criteria for determining the technical level of the object;

Criteria for determining the information potential;

- specific criteria specific to certain types of objects.

The importance of criteria containing the condition "sufficiency" in the selection of objects is determined by the following inequality:

$$Ee \geq En$$

$$Tr \geq Tn$$

where:

En - Estimated efficiency factor

Ee - normative efficiency factor;

Tr - determined payback period for the invested funds;

Tn - nominal time for redeeming the invested funds.

5.Functional Abilities of Artificial Intelligence

Artificial Intelligence can be used in the logistics information service for customer service.

Elements of the logistics service

Service - Time. The market demand for the accuracy of delivery and the time aspect has increased over the years.

Service - Logistic price. Logistics costs are costs that may be related to the company's logistics activities such as moving, storing and handling of goods, etc.

Service - transport and processing. Costs associated with moving goods are called transportation and handling costs.

Service - Storage. What determines the cost of storing is the amount of stored goods.

Conclusion

Information flows in the business organization should be formed on the basis of the characteristics of the production and economic activity of the whole chain through which the commodity product becomes an end product and then through the sales system reaches the end user. The management of this logistics chain of operations can be automated across the value chain, regardless of the level, nature, and geographical location of

the logistics components. Therefore, L-AMS is a new type of automation management system with the possibility of embedding E-components and artificial intelligence. The main difference between logistics AMS and other types of information systems is the level of integration of the information space both in horizontal and in the vertical direction.

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